INTERNATIONAL STANDARD

ISO 15531-1

First edition
2004-03-01

Industrial automation systems and integration — Industrial manufacturing management data —

Part 1: General overview

Systèmes d'automatisation industrielle et intégration — Données de gestion de fabrication industrielle —

Partie 1: Aperçu général

Reference number
ISO 15531-1:2004(E)

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Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15531-1 was prepared by Technical Committee ISO/TC 184, *Industrial automation systems and integration*, Subcommittee SC 4, *Industrial data*.

A complete list of parts of ISO 15531 is available from the Internet:

http://www.tc184-sc4.org/titles/Mandate_titles.rtf

Introduction

The information generated about the manufacturing process of an industrial product is very important for the life cycle of this product, notably in a context of sustainable development. Manufacturing may be defined as the transformation of raw material or semi-finished components leading to goods production. Manufacturing management is the function of directing or regulating the flows of goods through the entire production cycle from requisitioning of raw materials to the delivery of the finished product, including the impact on resources management.

A manufacturing management system manages the flow of materials and products through the whole production chain, from suppliers, through manufacturers, assemblers, to distributors and sometimes customers.

The relations among those partners may be identified and structured in an electronic form with a view to facilitate electronic exchanges. Then, information handled during these exchanges have to be identified, modelled and represented in such a way that they may be shared by a maximum of partners through the usage of standards for product and manufacturing data modelling.

The production planning functions within the supplier plants are assumed to have strong relationships with the master production scheduling people of the main plant, who share with them information on the likely pattern of the future demands to allow suppliers to plan in turn their production. On a day-to-day basis, the operational planning system of the main plant sends orders to the suppliers to ensure the availability of components, subassemblies and others such as resources needed to its manufacturing and assembly process.

From this approach, three main categories of data related to manufacturing management may be distinguished as follows:

— information related to the external exchanges, e.g., between main plant and suppliers;

— information related to the management of the resources used during the manufacturing processes;

— information related to the management of the manufacturing flows.

NOTE This information is usually provided within the main plant, and exchanged among the different machine tools, or production cells.

ISO 15531 is an International Standard for the computer-interpretable representation and exchange of industrial manufacturing management data. The objective is to provide a neutral mechanism capable of describing industrial manufacturing management data throughout the production process within the same industrial company and with its external environment, independent from any particular system. The nature of this description makes it suitable not only for neutral file exchange, but also as a basis for implementing and sharing manufacturing management databases and archiving.

The standard is focused on discrete manufacturing, but not limited to it. Then any modification or extensions to industrial that do not belong to discrete part manufacturing have always been under consideration when they did not imply any contradiction or inconsistency with the initial objective of the standard.

ISO 15531 addresses the three types of data described above. It does not standardise the model of the manufacturing process. The aim of ISO 15531 is to provide standardised data models for those three types of manufacturing management data. The purpose of that standard development is to facilitate the integration between the numerous industrial applications by means of common, standardised software that are able to represent these three sets of data.

This International Standard is organised as a series of parts, each published separately. The parts of ISO 15531 fall into the following series: production data for external exchange, manufacturing resources usage management data, manufacturing flow management data.

This part of ISO 15531 provides a general overview. It specifies the functions of the various series of parts of ISO 15531 and the relationships among them. It also specifies the relations between ISO 15531 and other related standards in its Annex B.

Industrial automation systems and integration — Industrial manufacturing management data — Part 1: General overview

1 Scope

ISO 15531 specifies the characteristics for a representation of manufacturing management information over the entire industrial process. It provides the necessary mechanisms and definitions to enable manufacturing management data to be shared and exchanged within the factory, with other plants or companies.

The standard is mainly focused on discrete manufacturing but not limited to it. It may also apply to any industrial processes that do not imply any contradiction or inconsistency with the basic principle of the standard.

The following are within the scope of ISO 15531:

— the representation of information needed to manage production and resources;

— the exchange and sharing of production information and resources information including storing, transferring, accessing and archiving.

EXAMPLE Information on resources and system capability and capacity, monitoring, maintenance, constraints and control information.

NOTE Maintenance constraints and relevant maintenance management data are taken into account from the point of view of their impact on the flow control.

The following are outside the scope of ISO 15531:

— architecture and methodologies for the modelling of an enterprise in its whole as well as the related tools;

— representation and exchange of product information;

— representation and exchange of computer-interpretable parts library information;

— representation of exchange of cutting tool data;

— technical maintenance information.

EXAMPLE Technical information that is included in devices repair, operation and maintenance manuals.
More specifically this part of ISO 15531 gives an overview of this International Standard and of the main principles used. It specifies the characteristics of the various series of parts in ISO 15531 and the relationships among them.

The following are specifically within the scope of this part of ISO 15531:

— general overview of the standard and of the main principles used;

— structure of the standard and relationships between the three series of parts which the standard is made of;

— definitions of terms used throughout this International Standard.

The scope of this part includes provisions of explanations addressing the following item that are issued in Annex B:

— how this standard fits with ISO 10303, with ISO 13584, and with other related standardisation works;

— the role and usage of manufacturing systems data exchange and how this standard may be used in conjunction with other standards to contribute to the integration of manufacturing applications.

The scope of each of the other parts of ISO 15531 is defined within the relevant part of each series.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

— ISO/IEC 2382-24:1995, *Information technology - Vocabulary - Part 24: Computer-integrated manufacturing*

— ISO/IEC 8824-1:1998, *Information technology - Abstract Syntax Notation One (ASN.1) - Part 1: Specification of basic notation*

— ISO 10303-1:1994, *Industrial automation systems and integration - Product data representation and exchange - Part 1: Overview and fundamental principles*

— ISO 10303-11:1994, *Industrial automation systems and integration - Product data representation and exchange - Part 11: Description methods: The EXPRESS language reference manual*

— ISO 10303-49:1998, *Industrial automation systems and integration - Product data representation and exchange - Part 49: Integrated generic resources: Process structures and properties*

— ISO 13584-1:2001, *Industrial automation systems and integration - Parts library - Part 1: Overview and fundamental principles.*

— ISO 13584-42:1998, *Industrial automation systems and integration - Parts library - Part 42: Description methodology: Methodology for structuring part families*

— ISO 14258:1998, *Industrial automation systems - Concepts and rules for enterprise models*

— ISO 15704:2000, *Industrial automation systems - Requirements for enterprise-reference architectures and methodologies*

— ISO 15926-1: — [1], *Industrial automation systems and integration - Integration of life-cycle data for process plants including oil and gas production facilities - Part 1: Overview and fundamental principles*

— ISO/TS 16668:2000, *Basic Semantics Register (BSR)*

— ISO/IEC 62264-1:2003, *Enterprise-control system integration - Part 1: Models and terminology*

3 Terms, definitions and abbreviations

3.1 Terms defined in ISO 10303-1

This part of ISO 15531 makes use of the following terms defined in ISO 10303-1:

— data;

— data exchange;

— information;

— product;

— product data.

[1] To be published.

3.2 Terms defined in ISO 10303-11

This part of ISO 15531 makes use of the following terms defined in ISO 10303-11:

— entity.

3.3 Terms defined in ISO/IEC 2382-24

This part of ISO 15531 makes use of the following terms defined in ISO/IEC 2382-24:

— manufacturing resources planning (MRP II);

— material requirement planning (MRP).

3.4 Terms defined in ISO 13584-42

This part of ISO 15531 makes use of the following terms defined on ISO 13584-42:

— basic semantic unit (BSU).

3.5 Terms defined in ISO 14258

This part of ISO 15531 makes use of the following terms defined in ISO 14258:

— enterprise;

— enterprise model.

3.6 Other terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.6.1
basic semantic register
basic register of semantics units.

NOTE Definition adapted from ISO/TS 16668:2000.

3.6.2
building block; construct
textual or graphical artefact designed to represent in a structured way the various information about common properties of a collection of objects or enterprise entities.

EXAMPLE Artefact designed for resources, activities, product, event or any phenomena representation.

NOTE Definition adapted from CEN/CENELEC ENV 40003 [1] and CEN/CENELEC ENV 12204 [2]. Building block and construct have the same meaning. Those European standards use the term construct without qualifier.

3.6.3
capability
quality of being able to perform a given activity.

NOTE The capability is defined by a group of characteristics that describes functional aspects of manufacturing resources or system.

3.6.4
capacity
capability of a system, subsystem or resource to perform its expected function from a quantitative point of view.

EXAMPLE The capacity of a system or a resource to produce a given quantity of output in a particular time period.

NOTE For a given system or resource the distinction between capacity available and capacity requested may be useful.

3.6.5
capacity planning
process of determining the required capacities for expected production.

3.6.6
cost control
application of procedures to monitor expenditures and performance against progress of projects and manufacturing operations with projected completion to measure variance from authorised budget and allow effective to be taken to achieve minimal cost.

NOTE That includes the act of gathering and checking cost information elements. The term may also apply to the function or services. Definition adapted from APICS dictionary [5].

3.6.7
continuous process
production process that lends itself to an endless flow of non discrete product or component.

NOTE This is the opposite of discrete part manufacturing as the material flow is continuous during the production process.

3.6.8
device
any identified physical equipment, system or subsystem that does not belong to software, data set or human resource class.

NOTE A device may nevertheless include software.

3.6.9
discrete manufacturing
production of discrete items.

EXAMPLE Cars, appliances or computer.

3.6.10
electronic data interchange (EDI)
automated exchange of predefined and structured data for business purpose among information systems of two or more partners.

NOTE Definition provided by ISO 16668:2000.

3.6.11
element
static representation of a part of the universe of discourse that may be identified and characterised by its behaviour and attribute.

NOTE A static representation is a snapshot of the part of the universe of discourse under consideration at a given time. It may include dynamic attributes as, for example, behaviour. Those attributes characterise the element as it is or as it is expected to be at a given time.

3.6.12
enterprise entity
any concrete or abstract thing in the universe of discourse of an enterprise.

NOTE The concept provided here belongs to the broader concept of entity as defined in European standards such as ENV12204 [2]. The concept of entity as defined in those standards has been restricted here to avoid inconsistency with the term of entity as defined in ISO 10303-11. Then excepted in the definition of universe of discourse the term entity applies in ISO 15531 with the definition provided by ISO 10303-11.

3.6.13
enterprise modelling
process of developing an enterprise model.

3.6.14
flow
motion of a set of physical or informational objects in space and time.

3.6.15
flow control
specific production control system that is based primarily on setting production rates and feeding work into production to meet these planned rates, then monitoring and controlling production.

NOTE That includes the act of checking and driving the flow according to a given purpose. The term may also apply to the function or service. Definition adapted from APICS dictionary [5].

3.6.16
flow model
representation or description of manufacturing related flows describing only the aspects to be relevant to its purpose.

3.6.17
industrial process
process with the purpose of providing direct contribution to the production of goods and associated services.

3.6.18
installation
initial process of enabling a resource to perform its requested activity.

3.6.19
inventory control
act or function of checking and maintaining stock items at a desired level.

3.6.20
just in time (JIT)
fact, or the related production organisation, of supplying work desks in due time with the strictly needed quantity of component and raw material.

NOTE The general definition of JIT is "A collective approach of continuous improvement in manufacturing, based on detection and progressive elimination of all waste". Only the restricted definition given here, which provides the most used meaning of JIT, is applicable in this standard.

3.6.21
main plant
primary plant of a company in the manufacturing process.

EXAMPLE The final assembly plant for a given product.

3.6.22
manufacturing
function or act of converting or transforming material from raw material or semi-finished state to a state of further completion.

NOTE Definition adapted from APICS dictionary [5].

3.6.23
manufacturing management
function or act of directing or regulating the flows of goods through the entire production cycle from requisitioning of raw materials to the delivery of the finished product, including the impact on resources management.

3.6.24
manufacturing planning
function of setting appropriate levels or limits to the future manufacturing operations according to sales forecast, economic constraints and resources requirements and availability.

NOTE Definition adapted from APICS dictionary [5].

3.6.25
manufacturing process
structured set of activities or operations performed upon material to convert it from the raw material or a semifinished state to a state of further completion.

NOTE Manufacturing processes may be arranged in process layout, product layout, cellular layout or fixed position layout. Manufacturing processes may be planned to support make-to-stock, make-to-order, assemble-to-order, etc., based on strategic use and placements of inventories.

3.6.26
master production schedule
representation of what a company plans to produce expressed in specific configurations, quantities and dates.

NOTE The master production schedule is not a sales forecast. Nevertheless the master production schedule must take into account this forecast as well as the production plan, the backlog availability of material, availability of capacity and management policies and goals. Definition adapted from APICS dictionary [5].

3.6.27
master production scheduling
function or the act by which the master production schedule is built, reviewed and adjusted.

3.6.28
model
representation or description of an entity or a system, describing only the aspects considered to be relevant for its purpose.

NOTE Entity is not used here with the meaning provided by ISO 10303-11 but with the sense usually given in ENV 12204 [2] (see note in clause 3.6.12).

3.6.29
process
structured set of activities involving various enterprise entities, that is designed and organised for a given purpose.

NOTE The definition provided here is very close to that given in ISO 10303-49. Nevertheless ISO 15531 needs the notion of structured set of activities, without any predefined reference to the time or steps. In addition, from the point of view of flow management, some empty processes may be needed for a synchronisation purpose although they are not actually doing anything (ghost task).

3.6.30
process control
function of maintaining a process within a given range of capabilities and capacities.

NOTE Definition adapted from APICS dictionary [5].

3.6.31
process plan
package of information needed to enable the achievement of a process.

NOTE Definition provided here is more general as well as more precise than the definition of ISO 10303-49, which is very close to the definition of «planning list» as proposed by APICS dictionary [5].

3.6.32
process planning
analysis and design of the sequences of processes, resources requirements, needed to produce goods and services.

NOTE This definition applies to discrete part manufacturing and continuous processes.

3.6.33
production activity control
function of routing and dispatching the work to be achieved through the production facilities.

NOTE Definition adapted from APICS dictionary [5].

3.6.34
production capacity
highest sustainable output rate that can be achieved with the current product specification, production scheme and available resources.

NOTE The production scheme is the mix of goods and products to be manufactured. Definition adapted from APICS dictionary [5].

3.6.35
production control
function of monitoring and controlling the movement of goods through the entire manufacturing cycle.

NOTE Definition adapted from APICS dictionary [5].

3.6.36
production cycle
total time required to manufacture an item, exclusive of lower level purchasing lead time

NOTE Definition adapted from APICS dictionary [5].

3.6.37
production facilities; manufacturing facilities
physical plant and equipment

NOTE That includes any kind of resource that is not directly related to the manufacturing process.

EXAMPLE Cooling system, carrying equipment, communication network.

3.6.38
production forecast
marketing expectations translated into meaningful terms for production.

3.6.39
production monitoring
function of checking and driving the status and the progress of production processes and activities.

3.6.40
production order control
control of the progress of each customer order, or stock through the successive operations of the production cycle.

3.6.41
purchase requisition
request to the purchasing department to purchase specified materials in specific quantities within a specified time.

NOTE Definition adapted from APICS dictionary [5].

3.6.42
quality assurance
all the planned and systematic activities implemented within the quality system that can be demonstrated to provide confidence that a product or service will fulfil requirements for expected quality.

NOTE Definition adapted from APICS dictionary [5].

3.6.43
resource
any device, tool and means, except raw material and final product components, at the disposal of the enterprise to produce goods or services.

NOTE 1 Resources as they are defined here include human resources considered as specific means with a given capability and a given capacity. Those means are considered as being able to be involved in the manufacturing process through assigned tasks. That does not include any modelling of an individual or common behaviour of human resource except in their capability to perform a given task in the manufacturing process (e.g.: transformation of raw material or component, provision of logistic services). That means that human resources are only considered, as the other, from the point of view of their functions, their capabilities and their status (e.g.: idle, busy). That excludes any modelling or representation of any aspect of individual or common «social» behaviour.

NOTE 2 This definition includes ISO 10303-49 definition.

3.6.44
resources requirements planning; rough cut capacity planning (RCCP)
process of converting the production plan and/or the master production schedule into capacity needs for key resources.

NOTE Definition adapted from APICS dictionary [5].

3.6.45
scheduling
act, function or result of planning occurrences of manufacturing activities.

3.6.46
semantic unit
concept unambiguously defined, independently of any particular physical representation and which is semantically complete.

NOTE 1 In any case the identification of each SU is unique (numerical). In the previous case each SU named in a particular language by the same expression, has its own identification number.

NOTE 2 This definition is the definition provided in the document ISO/TS 16668 BSR Rules, guidelines, and methodology currently submitted for CD ballot by ISO TC154 under the term of basic semantic unit (BSU). The name has been changed in this standard to avoid any confusion with the concept defined in ISO 13584-42 and according to the fact that there is proposal in ISO TC 154 to change the name BSU to SU.

3.6.47
semantic information unit
set of consistent information related to a collection of object or enterprise entities.

NOTE Semantic information unit is in this standard a set of information. It may includes several semantic unit.

3.6.48
supplier plant
plant, for a given supplier, which is involved in the manufacturing process.

EXAMPLE The supplier plant that is in charge of engine manufacturing and delivery for car assembly customer.

3.6.49
time model
model of the enterprise environment feature "time".

3.6.50
universe of discourse
the collection of concrete or abstract things that belong to an area of the real world, selected according to its interest for the system to be modelled and for its corresponding environment.

NOTE Definition adapted from CEN/CENELEC ENV 12204 [2].

3.7 Abbreviations

For the purposes of this document, the following abbreviations apply:

BSR Basic Semantic Register

BSU Basic Semantic Unit

CEN Comité Européen de Normalisation
(European Committee for Standardization)

EDI Electronic Data Interchange

ENV European Pre-standard

LAN Local Area Network

JIT Just In Time

MANDATE MANufacturing management DATa Exchange

MMS	Manufacturing Message Services
MRP	Material Requirement Planning
MRP II	Manufacturing Resources Planning
OPT	Optimized Production Technology
PERT	Planning Evaluation and Review Techniques
P-Lib	Parts Library
RCCP	Rough Cut Capacity Planning
SGML	Standard Generalized Mark-up Language
STEP	STandard for the Exchange of Product model data
SU	Semantic Unit
WAN	Wide Area Network

4 Overview of ISO 15531

Manufacturing management data define information used to manage the way of making products. This information does not specify any particular product neither any industrial process.

4.1 Concepts provided

ISO 15531 is intended to mainly address industrial discrete manufacturing activities. But ISO 15531 is not limited to this type of process and is applicable to many other industrial processes and in particular to continuous processes.

Manufacturing management information includes three main types of data that may have different kinds of representation since their concerns and usage are different. They have to be consistent between them and with the other data exchanged in the production process, such as product data, component data and cutting tools data.

ISO 15531 is divided into three series of parts. These series of ISO 15531 parts are strongly related. They are checked to preserve the consistency of the whole standard.

ISO 15531 addresses operations dealing with product manufacturing, and makes use of components descriptions. Since that requires avoiding any contradiction or inconsistency between ISO 15531, ISO 10303 and ISO 13584, each part of ISO 15531 is checked against ISO 10303 and ISO 13584. In addition the different parts of ISO 15531 make use of the EXPRESS language.

4.2 Parts 15531-2x series (Production data for external exchanges)

The parts belonging to this series concern the representation of production related information that has to be exchanged with the external environment of the company during the production process.

NOTE 1 The external environment includes, first, customers and suppliers. It may include other kinds of partners involved in the manufacturing process.

The aim is to model the main production information exchanged between industrial companies, in order to improve that exchange and its integration with the usage of various EDI protocols.

The scope of the parts in this series includes all the information and functional requirements necessary to support quality, and order management. This information may be planning, executing, controlling and monitoring of product quality, orders and shipments. This includes all the data describing order flows.

EXAMPLE 1 The EDI protocols used to exchange this information may be chosen among EDIFACT, X12 or other international, national or business EDI standards.

The input and output data (from an external point of view) needed for planning, executing and controlling, are taken in account, as well as the data which have to be exchanged with customers, material and service suppliers.

Then the parts in this series of the standard enable the provision of a formal description of order information exchange with customer and the supply chain, allowing order management based on standardised representation of exchanged, archived or shared data.

EXAMPLE 2 Planning, execution, controlling and monitoring of orders.

The same formal description applies to quality information exchange, under the same conditions for quality management. Of course it also captures the semantics of the previous functions.

NOTE 2 Specific classes, attributes and class libraries may be necessary to satisfy the requirements or the previous goals.

The parts in this series of the standard deal with modelling of data exchanged between an industrial manufacturing company and its environment of manufacturing management activities.
These data are needed to manage the whole manufacturing process.

They are required at various stages of that manufacturing process by various departments involved in it. They especially address the following data:

— data exchanged between commercial and manufacturing areas or sectors;

— information required for manufacturing planning;

— information needed from manufacturing orders;

— information needed from purchasing area;

— information required to monitor suppliers and subsidiaries;

— information required to support receiving and delivering of products.

NOTE 3 Some basic function such as invoicing, logistic function may be performed out of the company. Some of them may have a direct impact on the manufacturing process. In any case, the management of the manufacturing process provides data to the environment and needs information from this environment. Manufacturing orders, for example, include information that may be provided by the environment of the enterprise such as quantity of product as well as delivery schedule. The requirement of manufacturing management data exchange between companies is increasing with the development of the «virtual enterprise».

4.3 Parts 15531-3x series (Manufacturing resources usage management data)

The parts in this series address the resource usage management, operation management of manufacturing devices, installation and facilities. They also include quality features, maintenance features and safety features.

NOTE 1 Resource usage management includes resource configuration and capabilities.

NOTE 2 Maintenance features are taken into account from the point of view of resource availability.

Three different aspects are considered about the resources:

— their description, the way of using and maintaining them;

— the description of the activities, operations and functions a resource is able to achieve (its capacity and capability);

— the model of information needed to define, operate, trigger, estimate and monitor the resource.

NOTE 3 The first aspect means resource description and the way of using and maintaining it. The parts in this series do not address this aspect neither raw material or intermediate product.

The description of capacities, and capabilities of the resources are modelled at a very generic level, enabling its use to develop more precise resources models aimed at specific industrial activities, or specific functions.

The parts in this series of the standard deal with data models able to be stored in an industrial company's resource database. These data stored in those databases may be shared, archived, and exchanged. They are supposed to be used for resources usage and manufacturing management.

They address the following data:

— performance metrics;

— input and output resources definition;

— capacity and capability;

— tools and application software needed, in relation with specific activity;

— capacity of internal controls and intelligence;

— input and output information requirement and availability;

— standard references for resources;

— maintenance scheduling and monitoring;

— cost elements.

4.4 Parts 15531-4x series (Manufacturing flow management data)

The parts in this series address the material flow control, and provide a standard for the representation of data and elements which support the control and the monitoring of the flow of material in manufacturing or industrial processes. This includes all the elements describing the material flow, including inventory. They are strongly related to resources usage management data.

On the basis of existing standards for process plans, the standard enables the description of:

— materials flows in industrial discrete manufacturing processes as well as in other industrial processes;

— all the information necessary for scheduling, controlling and monitoring the flow of material.

NOTE 1 The standard is mainly focused on manufacturing processes. However, other industrial processes may be addressed by the standard itself or through some potential extensions.

First, this series of parts gives provisions for the definition and description of a data model of a production process from the point of view of the material and information flows.

The building blocks provided by this data model enable each company to individually model the relevant monitoring and control information with a maximum of flexibility relative to the changing situations and the possibility of adapting to changing organisational circumstances. Focused on the production process, they do not address the whole modelling of the enterprise.

The building blocks encompass the semantics for the support of the interactions between the different monitoring and control systems. They also support the modelling of interfaces with related organisational functions.

EXAMPLE Product design, process planning, quality assurance.

The building blocks are semantic information units needed to describe, after specialisation and instantiation any information relevant to planning, scheduling, monitoring and controlling certain manufacturing processes in different levels of abstraction.

NOTE 2 It is not the aim of the parts in this series to develop and provide a reference model valid for all the manufacturing processes or elements at any level of detail, that is role of the specialisation and instantiation activity.

This series of parts deal with the description and analysis of problem specific algorithms and methods,

in the domain of scheduling. Those algorithms accommodate the special requests of controlling, and monitoring systems, notably interruption requests, and must allow for the inclusion of the available knowledge.

Furthermore those series of parts deal with the development of required services, in order to address the problem of the interruption of scheduling, planning and monitoring processes, notably the occurrence of unsolicited trouble-messages, and to manage, in an interactive way, the simulation of different situations.

The parts in this series address, or are concerned with the representation of data supporting partly or totally manufacturing management processes, such as:

— definition of production levels;

— production control;

— manufacturing planning;

— resource requirements planning;

— just in time (JIT);

— optimised production technology (OPT);

— planning evaluation and review techniques (PERT);

— production monitoring;

— cost accounting;

— process planning;

— bills of material;

— process plans.

5 Relationships between the various series of parts of ISO 15531

As already explained ISO 15531 is divided into three series of parts. Although they are strongly connected and related, these series of parts address specific concern and are developed separately. This part of ISO 15531 provides the definitions of the main concepts and the relationships between these concepts.

Each series of parts includes its own overview document as a specific part. They also include a detailed development on the relationships between the concerned series and the other ISO 15531 documents.

ISO 15531-2x series of parts address the data exchanged or shared with the environment of the company or between different plants of the company. Those data that are received from the

environment or sent to it are also used internally for the manufacturing process management and are strongly involved in the resources management and the flow control.

ISO 15531-3x series of parts addresses the data used to manage all the resources involved in product manufacturing. Those resources are any manufacturing devices, or facilities that contribute to enterprise production of goods or services as well as human resources, software and data set. Those data may sometimes come from outside the enterprise (or the plant), they also may have to be sent outside. Those data are also a part of the manufacturing information flow.

ISO 15531-4x series of part include data for time modelling as well as any kind of data required to manage any flow related to manufacturing process. The impact, for consistency, of data used for resources management or data exchanged with the environment of the enterprise is major importance for flow management data modelling.

The three series of parts of the standards are in close relationship. Some of the information represented in the standard comes from the environment of the enterprise (ISO 15531-2x), and then it spreads over the whole production cycle to be ultimately exchanged again with the environment. The production process, data exchanged during the production cycle are strongly related to the management of the whole manufacturing company information system through a precise knowledge of the data flows handled by this information system, but also through a precise management of time synchronisation processes. Then data exchanges during the production cycle are strongly related to the system management and to the time and flow models (ISO 15531-4x).

The same approach also addresses information on resources usage management (ISO 15531-3x). In that way, information on internal system management (ISO 15531-4x), resources usage management (ISO 15531-3x) and information to be exchanged outside of the company (ISO 15531-2x), are fully consistent.

NOTE Company environment includes suppliers, customers, and any partners from which data exchanged may have an impact on manufacturing. It may include, depending on company (or factory) organisation some subsidiaries or factories belonging to the same group.

Annex A
(normative)

ASN.1 Identifier of ISO 15531-1

To provide for unambiguous identification of an information object in an open system, the object identifier

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iso standard 15531 part 1 version 1
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is assigned to this part of ISO 15531. The meaning of this value is defined in ISO/IEC 8824-1 and is described in ISO 15531-1.

Annex B
(informative)

Relationship between ISO 15531 and other standards or standardisation works addressing integration in manufacturing; role and usage of ISO 15531

B.1 ISO 15531 and the standards developed in ISO TC 184/SC4

ISO TC 184/SC4 is developing standards that provide capabilities to describe and manage product data throughout the life of the product. The work of the TC 184/SC 4 includes the development of standards in four areas of product or production data technology.

These areas include:

— industrial manufacturing management;

— parts library ;

— life-cycle data for oil and gas production facilities ;

— product data representation and exchange.

The scope of ISO TC 184/SC 4 includes all the industrial data related to industrial product. It then includes, but is not limited to the following:

— geometric design and tolerance data;

— product support and logistics;

— material and functional specifications;

— life-cycle data;

— product differentiation and configuration;

— quality data;

— process design data;

— disposal planning data;

— production data (including cost).

Are also included organisational data such as the relationship between enterprises and the relationship between components of a single enterprise for the purposes of supplier identification, and personnel data to the extent of identification of approvals. Business planning data such as profit projections, cash flow and any other personnel data or organisational data are specifically excluded.

The goal of the TC 184/SC 4 is the creation of standards that enable the capture of information comprising a computerised product model in a neutral form without loss of completeness and integrity throughout the life cycle of the product.

B.1.1 ISO 10303: STandard for Exchange of Product model data

ISO 10303 is an International Standard for the computer-interpretable representation and exchange of product definition data. This concept of «product» defined in ISO 10303-1 is a powerful and original feature of the standard, compared to other exchange standards. The objective is to provide a mechanism capable of describing product data, throughout the life cycle of a product, independent from any particular system.

NOTE 1 ISO 10303 definition «product»: «thing or substance produced by a natural or artificial process».

NOTE 2 ISO 10303 definition of «product data»: «representation of facts, concepts or instructions about one or more product in a formal manner suitable for communication, interpretation, or processing by human beings or by automatic means».

The nature of this description makes it suitable not only for neutral file exchange, but also as a basis for implementing and sharing product databases and archiving. The standard is organised as a series of parts, each published separately:

— description methods;

— integrated resources;

— application protocols;

— abstract test suites;

— implementation methods;

— conformance testing.

B.1.2 ISO 13584: Parts Library

The purpose of this International Standard is to specify a form for the unambiguous representation and exchange of computer-interpretable parts library information. This form is independent of any particular computer system, allows any kind of part representation category, and enables consistent implementations across multiple applications and systems. The standard permits different implementation technologies to be used for storing, accessing, transferring and archiving parts library data. The implementations may be tested for conformance.

This International Standard separates:

— the information about the structure of a parts library;

— the information about each part or family of parts that belongs to the parts library.

The standard makes use of the EXPRESS language to specify the information about the structure of a parts library. It allows the information about each part, or each family of parts belonging to a parts library to be specified by different standards, those enabling this information to be referenced from the information structure of the parts library. The conformance testing of the implementations will use the same methodology and framework as defined in the ISO 10303 standard.

EXAMPLE Standards may be for example ISO 8879 SGML, ISO 10303 STEP, IEEE 1076 VHDL.

B.1.3 ISO 15531: MANDATE (MANufacturing DATa Exchange)

ISO 15531 defines a standard for the modelling of the information related to manufacturing management. Manufacturing management is the answer to the question, "How do we manufacture products?". Manufacturing is the transformation of material from one state to another thus contributing to goods production. Manufacturing management is the function of directing or regulating the flows of goods through the entire production cycle from requisitioning of raw materials to the delivery of the finished product, including the impact on resources management.

NOTE Material may be raw material or semi-finished components.

A manufacturing management system must manage the flow of materials and products through the whole production chain, from suppliers, manufacturers, assemblers, through to distributors and sometimes customers.

ISO 10303 takes a product-oriented view of manufacturing, while ISO 15531 is concerned with the data defining the processes, within the global enterprise organisation, used to produce the products.

B.2 Links and relationship of ISO 15531 with other standardisation works

Appropriate related standards as well as standardisation efforts are considered in this standard, among which ISO 10303, ISO 13584, EDIFACT, as well as standards or efforts dealing with enterprise modelling.

EXAMPLE 1 Enterprise modelling related standards are typicaly the standards developed by ISO TC 184 SC5/WG1 and by CEN TC310/WG1 such as ISO 14258, ISO 15704, CEN ENV 40003, CEN ENV 12204.

Other related standardisation work such as work in progress in the ISO TC29/WG34 on "Cutting tools" data exchange. The formalisms developed in ISO 15531 support these interactions.

When establishing a product description, designer has complementary approaches:

— to satisfy the function the product has to comply with;

— to give a clear and exhaustive definition of corresponding product;

— to choose product shapes compatible with available manufacturing processes;

— to express the expected life cycle for the product.

During the manufacturing processes, people use data defined by the designers, and they do not have to re-do the work already done. Raw material, or intermediate products, are clearly product-related. They are within the scope of ISO 10303. They are then out of the scope of ISO 15531. In the same way some data about components have to be exchanged during the production process inside the factory and/or outside the factory (i.e. through the purchasing department). They belong to the scope of ISO 13584, they are not in the scope of ISO 15531. Moreover many other kinds of data, which are defined in other standardisation are used, shared or exchanged during the production process inside the company or with its environment. It is not the purpose of ISO 15531 to duplicate those works.

EXAMPLE 2 Works done in ISO TC29/WG34 on «Cutting tools», or in TC184 SC1/WG7, work in progress in UN-EDIFACT and ISO TC154.

Then the models, constructs and data representations provided are be consistent with those provided by ISO 10303 and ISO 13584 in order to make integration in manufacturing easier and to ensure interoperability all over the production process. That means, in particular, that those standards using EXPRESS language have to be fully compliant with the SC4 standards.

EXAMPLE 3 One of the main relationship between ISO 15531 and ISO 10303 is the relation written in ISO 10303-41 e2 from some time related entity such as point_in_time to the relevant entity in ISO 15531-42 (Time model) point_of_time.

EXAMPLE 4 The use of ISO 13584-42 services to contribute to the description of any kind of capability in ISO 15531-32

They also contribute to facilitate interoperability along the external data exchanges, and have to be compliant with the standards available or in progress in the EDI area; they are one of the key tools for the development of the extended enterprise, through a concurrent engineering implementation.

EXAMPLE 5 EDIFACT, ANSI X12, BSR.

Moreover, since ISO 15531 will be one of the tools of the manufacturing integration process, it should also have to be compliant with upper level integration tools such as those developed in the field of Enterprise Modelling by the ISO TC184/SC5/WG1.

EXAMPLE 6 ISO 14258, ISO 15704.

Finally, ISO 15531, which as well as ISO 10303, lays in the core of the integration process in manufacturing has to ensure data integration and facilitate the interoperability industrial application by taking into account all the standards developed in that field and also by providing the appropriate relations between them.

Nevertheless, the point of view of ISO 15531 is different from that one adopted in those standards. Then, even though any duplication of work should be avoided, some of the related information has to be reconsidered and sometimes represented in a specific way, or with additional properties, which should however be compatible with the other related standards (in particular ISO 10303, and ISO 13584) in any case. For example:

— The part list is written by the designer to define the composition of assemblies. Most of the time, it is re-built by the manufacturing management. This is due to the fact that the designer has a top-down approach, from the whole product to assemblies and spare parts, while production management has a bottom-up point of view, because of its interest in production in pulled flow for a given level of inventories and resources availability.

— The process plan is a specific way to define the steps of the transformation during manufacturing. The link with the product to be made (thus with ISO 10303) is obvious (see ISO 10303-49). However, available resources and tools are also strongly concerned and that is why this item is common to both activities.

Product life cycle deals with a specific product, or with a specific item of a specific product (e.g. tracking). Manufacturing management deals with the way, or the organisation, during the routing of one production batch within the factory. Sometimes product life cycle is for the whole process of product manufacturing, sometimes for one, or several spare parts.

Those examples explain the reason why the ISO 15531 approach is different, and complementary to those of ISO 10303, ISO 13584, BSR, EDIFACT, Enterprise Modelling, etc. Supply cannot be considered as linked to the product. Most of the data (technological data) are linked to production management; of course, a part of this work will have to be common with the EDIFACT organisation. The problem is the same for shipping.

Except for very specific cases of prototypes, or unique parts, most of the data used during manufacturing cannot be defined at the product design stage, because they are determined by situations evolving with time, and also by variable characteristics. Thus the needs are not the same.

Since ISO 10303, and ISO 15531, as well as EDI standard and ISO 15531, or enterprise modelling standards and ISO 15531 consider common items in a different way, there is no overlapping. There is nevertheless a very strong relationship between those standardisation efforts and a need of a very close co-ordination between the different developments to avoid duplication of work.

B.3 Role and usage of ISO 15531 for manufacturing systems data exchange and integration

B.3.1 Current situation

To date, standards developed within ISO TC 184/SC4 refer to:

— product data: ISO 10303;

— component data: ISO 13584;

— production data: ISO 15531;

— Life-cycle data ISO 15926.

ISO 15531 encompasses:

— external data;
— manufacturing resources data;
— manufacturing flow data.

On the other hand, other subcommittees within ISO TC184 are in charge of the development of standards in the domain of:

— physical device control;

— robots;

— architecture and communications.

Then two levels of integration or merging of the standards developed within the TC 184/ SC 4 may be proposed.

A first level merging of the standards, concerning those developed within the SC4, may be the development of a common generic structure addressing items of information (product, component data) exchanged between on going processes whose sequencing and controlling would be assumed by production data.

Those items of information may be either really exchanged between the tasks, extracted from (local or external) repositories, or even retrieved from external sources.

EXAMPLE 1 Exchanges between different companies, or within the same company, when the plants are not physically located at the same place.

In that case, it is obvious that some exchange protocols are needed, built on common items of communication (common generic resources).

We must however notice that this level does not enable a high level of genericity, since the semantics used within the exchanges remain close to the context both of the product to be made, and of the way of making it.

In the second level of merging, ISO 15531 may be seen as providing the structure of a network, defined at the overall level of the company (or in between the companies involved in the manufacturing process):

a) the tokens to be exchanged within this LAN, or WAN (according to the structure of the company(ies)) are provided by the items of information defined by ISO 10303, or ISO 13584, under the form of product, or component data;

b) those tokens are conveyed within flows defined between functions, or processes, or even tasks, achieved within the manufacturing company or between the main company and subsidiaries;

c) synchronising of those flows is provided by protocols. More generally, these protocols are responsible for the management of the processes, and check for consistency. They also assume the routing, when and where necessary, of the "packets" of information (ISO 10303 and/or ISO 13584 data) they deal with.

d) whenever useful, storage devices, and external communications will be solicited;

e) the above mentioned activities define functions, or may also be seen as resource constructs of a more general view, provided by a generalised enterprise architecture;

f) the coherence and the consistency of the items of information handled are provided by the integration of ISO 15531 within this more generic structure, including both technical and non technical concepts and functions. The overall management rules are provided by this generic structure;

g) ISO 15531 may be seen as an enabling gateway between:

1) product models standards (e.g. ISO 10303, ISO 13584, Cutting tools);

2) manufacturing messages, or protocols specifications;

3) enterprise model standards.

EXAMPLE 2 ISO 14258, CEN/CENELEC ENV 40003 [2], CEN/CENELEC ENV 12204 [3].

B.3.2 ISO 15531 as a generic support for integration

Whatever the level of merging, or integration of this standard within generic approaches, ISO 15531 may be considered as a generic support provided that the following conditions apply:

— possible, coherent and non-ambiguous agreement on the identification of the different processes used in manufacturing engineering, and corresponding representation;

— identification of the flows handled during the manufacturing process: control, resources, and data;

— more generally, identification of all the functions to be assumed during a manufacturing process;

— use of methodologies such as MRP, MRPII, where this type of information is already identified, recognised and agreed on;

— clear distinction between external and internal information, as well as information coming from data stores, or information dealing with resources.

It is not the objective of this part of ISO 15531 to state the conditions to be required from candidate standards. Nevertheless these conditions are implicit within each of the series of parts they concern, and they will be applicable to the series of parts they refer to.

B.3.3 Elements about the consideration of ISO TC 184/SC4 common resources

Since a part of the relative function of ISO 10303, ISO 13584, and ISO 15531 (or of the objects they handle) will be shared within a more global model, issued from the integration of some of their concepts, it should be feasible to envision the possibility to build common resources.

These common resources will have to be accurately defined, and also checked for their relevance, their adequacy, whatever the usage made. Rules have to be defined for the usage of those common resources in ISO TC 184/SC4 standard.

On a more general level, at the second level of merging or integration, it could also be possible to elaborate common "ISO TC 184/SC4 resources", that handle and integrate in a single representation concepts coming both:

— from the micro level (the data to be exchanged);

— from the macro level (the functions to be assumed by the company);

thus providing the common meta-level of representation between product and production.

Annex C
(informative)

Capability and capacity

The " General system theory" build up in 1937 by Ludwig Von Bertalanffy and developed till now by hundreds of author is fundamental basis of ISO 15531 approach. In complement of the definitions provided in this standard it may be useful to provide the following precision on capability and capacity:

— Capability is essentially a functional concept. It may sometimes include quantitative properties or attributes; in that case the quantitative aspect solely addresses some needed precision on capability;

— Capacity is strictly a quantitative concept that characterises the performance of the resource in the achievement of its activity.

EXAMPLE 1 The characteristics in term of size of the parts or in term of precision for the milling capability of a milling machine belong to its capability.

EXAMPLE 2 Quantity of product provided by the resource per unit of time characterises its capacity.

It is possible to consider for certain modelling purposes that the capacity of a resource may be one of the characteristics of the capability of a resource. Nevertheless this must be avoided, in order to prevent any confusion. But it is never possible to consider the opposite (Capability as a characteristic of capacity).

Moreover capability and/or capacity are predefined concepts they attribute of resources and ore activity independently. In the case of capability: the set of capabilities provided by a resource is a characteristic of the resource (an a priori data). At the starting point this capability is not associated with any activity. In the same way the set of capabilities required by an activity is also a characteristic of this activity At the start point there is no resource associated to this required activity.

It is the association of a resource with an activity with the corresponding control in the context of a specific application (e.g. production or scheduling application) that constitutes the system and build the relationship between a capability provided by the resource and the capability requested by the activity.

EXAMPLE 3 A painting robot that is idle is only a resource, possibly available. It nevertheless exists and its existence (with all its capabilities and its capacity) may potentially be taken in account in a scheduling application. On the other hand the painting activity without any resource (human or robot) to achieve this function is a concept that will only become actual when this activity is associated with a resource in a painting operation. It is up to the scheduling application to enable the association of this concept with a given resource in the context of an operational system. The resource "painting robot" is not a system. The activity "painting" is a concept only. A painting robot that is actually painting under the ad-hoc control is a painting system.

In most cases the panel of capabilities required by a given activity is only a subset of the panel of

capabilities provided by the resource that is associated with this activity in the system. When the difference is too big the resource is under employed.

On the other hand, if the resource is unable to provide all the capabilities required by the activity, there is no possible production, no possible manufacturing (The resource has to be replaced with a more convenient one). The system therefore does not exist and cannot run.

Some times the capacity provided by a resource is bigger than that required by the activity with which the resource is associated. In most cases both capacities are comparable. Nevertheless if for any reason (failure or anything else) the resource associated with a given activity is not able to provide all the capacity required by the activity, the production is most often reduced. The system runs in a decreased mode (the question is : is this decreased mode acceptable?).

NOTE Annex F of ISO/IEC 62264-1:2003 provides a more complete vision on capability, capacity, resource, system and time in the framework of a systemic approach. This annex is an extract and an adaptation of ISO/IEC 62264-1:2003, Annex F.

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ICS 25.040.40

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